CLAIMS

1. A near-field exposure method wherein a pressure difference is applied to between a front face and a rear face of an elastically deformable exposure mask to cause deformation of the exposure mask in accordance with a substrate to be exposed and to cause the exposure mask surface to follow a surface irregularity state of the substrate so that these surfaces are closely contacted to each other, for exposure based on near field light, characterized in that:

the pressure difference applied to between the front and rear faces of the exposure mask is set at a predetermined pressure difference corresponding to surface roughness of the substrate to be exposed.

2. A method according to Claim 1, wherein the predetermined pressure difference is set at a pressure difference larger than a minimum pressure P which is determined to satisfy equation (1) below, in relation to maximum surface roughness w at a measurement length a of the substrate to be exposed:

$$P = P_m + E\frac{16hw\left(4h^2 + (7-\nu)w^2\right)}{3a^4(1-\nu)} \quad \ldots(1)$$

wherein h is a thickness of a thin-film mask base material, E is a Young's modulus, ν is a Poisson's ratio, P_m is a pressure difference for roughly contacting a first substrate and a second substrate with each other.

3. A method according to Claim 2, wherein the predetermined pressure difference is set at a pressure difference larger than the minimum pressure P only when the surface roughness of the substrate to be exposed is greater than a reachable depth of the near field light.

4. A near-field exposure apparatus for performing an exposure on the basis of near field light, said apparatus comprising means for holding a thin film mask, a pressure container capable of applying a pressure to apply a pressure difference to between a front face and a rear face of the thin film mask, control means for controlling the pressure difference, a stage for holding a substrate to be exposed, and a light source,

characterized in that:

said control means is operable to set the pressure difference at a predetermined pressure difference corresponding to surface roughness of the substrate to be exposed.

5. An apparatus according to Claim 4, wherein said control means is operable to set the predetermined pressure difference at a pressure difference larger than a minimum pressure P which is determined to satisfy equation (1) as recited in Claim 2, in relation to maximum surface roughness w at a measurement length a of the substrate to be exposed.

6. An apparatus according to Claim 5, wherein the predetermined pressure difference can be set at a pressure difference larger than the minimum pressure P only when the surface roughness of the substrate to be exposed is greater than a reachable depth of the near field light.

7. An apparatus according to any one of Claims 4 - 6, further comprising measuring means for measuring surface roughness of the substrate to be exposed.

8. A near-field exposure mask to be used in an exposure process based on near filed light while a pressure difference is applied to between a front face and a rear face of an elastically deformable exposure mask to cause deformation in accordance with a substrate to be exposed and to cause the mask to follow a surface irregularity state of the substrate so that these surfaces are closely contacted to each other, wherein the exposure mask comprises a transparent thin-film mask base material and a light blocking film formed thereon, characterized in that:

the thin-film mask base material has a predetermined thickness determined on the basis of surface roughness of the substrate to be exposed and a pressure difference to be applied to between the front and rear faces of the mask during the exposure.

9. A near-field exposure mask according to Claim 8, wherein the predetermined thickness is set at a thickness smaller than a maximum film thickness determined to satisfy equations (2a) and(2b) below:

$$w(a,h,\Delta P)=\frac{4h^2}{7-\nu}\frac{1}{\left[R(a,h,\Delta P)\right]^{1/3}}+\frac{\left[R(a,h,\Delta P)\right]^{1/3}}{3} \quad ..(2a)$$

$$R(a,h,\Delta P)=\frac{1-\nu}{7-\nu}\frac{81a^4\Delta P}{32hE}+\sqrt{1728h^6+\left(\frac{1-\nu}{7-\nu}\frac{81a^4\Delta P}{32hE}\right)^2} \quad ..(2b)$$

wherein h is a thickness of a thin-film mask base material, E is a Young's modulus, ν is a Poisson's ratio, ΔP is an applied pressure to be applied after the rough contact, and w is surface roughness at a measurement length a.

10. A near-field exposure mask according to Claim 9, wherein the predetermined thickness is set at a thickness which is smaller than a smallest value of maximum thicknesses determined in accordance with equations (2a) and (2b) mentioned above with reference to those substrate portions, respectively, in which portions, among largest surface roughnesses at different measurement lengths with respect to the substrate to be exposed, the value of roughness is greater than a reachable distance of the near field light.

11. A device manufacturing method, comprising:

a preparing step for preparing a substrate for device production;

an applying step for applying a photosensitive resist for exposure, to the substrate to thereby provide a substrate to be exposed;

an exposure wherein a pressure difference is applied to between a front face and a rear face of an elastically deformable exposure mask to cause deformation of the exposure mask relative to the substrate to be exposed and to cause the exposure mask surface to follow the surface irregularity state of the substrate to be exposed, so that these surfaces are closely contacted to each other for exposure based on near field light, and wherein the pressure difference to be applied to between the front and rear faces of the exposure mask for the exposure is set at a predetermined pressure difference corresponding to surface roughness of the substrate to be exposed;

a developing and etching step for performing development and etching to the substrate having been exposed; and

a process step for performing a predetermined process to the substrate in accordance with a device to be produced, whereby a device is produced.